CLAIMS

What is claimed is:

1. A method of detecting accumulation of material deposits within a fluid flow conduit, the method comprising:

providing, by a controller, an excitation signal to a heating element of the fluid flow conduit;

obtaining, by the controller, electrical data of the heating element in response to providing the excitation signal, wherein the electrical data indicates a voltage, an electric current, or a combination thereof;

obtaining, by the controller, thermodynamic data of the fluid flow conduit in response to providing the excitation signal, wherein the thermodynamic data includes heat flux data, diffusivity data, temperature differential data, or a combination thereof, wherein the temperature differential data indicates a temperature difference between a temperature of the fluid flow conduit and a setpoint temperature of the fluid flow conduit; and

determining, by the controller, an amount of material deposits based on the thermodynamic data and the electrical data.

2. The method of Claim 1, wherein the thermodynamic data includes the heat flux data, and wherein the method further comprises:

determining an aperture size of the fluid flow conduit based on the heat flux data, wherein the amount of material deposits is further based on the aperture size.

3. The method of Claim 1, wherein:

the excitation signal has a predetermined pulse length;

the thermodynamic data includes the diffusivity data; and

the diffusivity data indicates a measured thermal diffusivity as a function of the predetermined pulse length.

4. The method of Claim 1 further comprising providing the excitation signal to the heating element to have a temperature of the fluid flow conduit reach a first setpoint temperature, wherein:

the thermodynamic data further includes time data; and

the time data indicates an amount of time to have the temperature of the fluid flow conduit reach a second setpoint temperature, and wherein the second setpoint temperature is less than the first setpoint temperature.

5. The method of Claim 1 further comprising obtaining a temperature of the fluid flow conduit in response to providing the excitation signal, wherein:

the excitation signal has a predetermined electrical power and the setpoint temperature of the fluid flow conduit associated with the predetermined electrical power;

and

the thermodynamic data includes the temperature differential data.

6. The method of Claim 5, wherein the temperature and the setpoint temperature are associated with a predetermined location of the fluid flow conduit.

7. The method of Claim 1 further comprising:

providing the excitation signal to a second heating element of the fluid flow conduit, wherein:

the excitation signal has a predetermined electrical power,

the heating element is provided proximate to a first location of the fluid flow conduit, and

the second heating element is provided proximate to a second location of the fluid flow conduit; and

obtaining a first temperature and a second temperature of the fluid flow conduit in response to providing the excitation signal, wherein the first temperature is associated with the first location, and the second temperature is associated with the second location, wherein:

the thermodynamic data includes the temperature differential data; and

the temperature differential data indicates a temperature difference between the first temperature and the second temperature.

8. The method of Claim 1 further comprising determining the amount of

material deposits based on a fluid flow rate of the fluid flow conduit.

9. The method of Claim 1 further comprising generating an alert in response to the amount of material deposits exceeding a threshold value.

10. The method of Claim 1, wherein the heating element is integrated with the fluid flow conduit.

11. The method of Claim 1, wherein the heating element is disposed on an exterior surface of the fluid flow conduit.

12. The method of Claim 1, wherein the electrical data indicates a power consumption of the heating element when the excitation signal has a predetermined electrical power.

13. A system for detecting accumulation of material deposits within a fluid flow conduit, the system comprising:

a processor; and

a nontransitory computer-readable medium comprising instructions that are executable by the processor, wherein the instructions comprise:

providing an excitation signal to a heating element of the fluid flow conduit, wherein the excitation signal has a predetermined electrical power;

obtaining thermodynamic data of the fluid flow conduit in response to providing the excitation signal, wherein the thermodynamic data includes heat flux data, diffusivity data, time data, temperature differential data, or a combination thereof , wherein the temperature differential data indicates a temperature difference between a temperature of the fluid flow conduit and a setpoint temperature of the fluid flow conduit associated with the predetermined electrical power; and

determining an amount of material deposits based on the thermodynamic data, the predetermined electrical power, and a fluid flow rate of the fluid flow conduit.

14. The system of Claim 13, wherein the instructions further comprise providing the excitation signal to the heating element to have a temperature of the fluid flow conduit reach a first setpoint temperature, wherein:

the thermodynamic data further includes time data; and

the time data indicates an amount of time to have the temperature of the fluid flow conduit reach a second setpoint temperature, wherein the second setpoint temperature is less than the first setpoint temperature.

15. The system of Claim 13, wherein the instructions further comprise:

providing the excitation signal to a second heating element of the fluid flow conduit, wherein:

the excitation signal has a predetermined electrical power,

the heating element is provided proximate to a first location of the fluid flow conduit, and

the second heating element is provided proximate to a second location of the fluid flow conduit; and

obtaining a first temperature and a second temperature of the fluid flow conduit in response to providing the excitation signal, wherein the first temperature is associated with the first location, and the second temperature is associated with the second location, wherein:

the thermodynamic data includes the temperature differential data; and

the temperature differential data indicates a temperature difference between the first temperature and the second temperature.